

TECHNICAL COMMITTEE REPORT:
Yukon River Salmon Run Outlooks for 2000

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YUKON RIVER JOINT TECHNICAL COMMITTEE

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1.0 INTRODUCTION

The U.S./Canada Yukon River Joint Technical Committee (JTC) was tasked by the Chief Negotiators, at a government-to-government meeting on 21-22 March 2000, to prepare salmon outlooks for the 2000 season prior to a negotiation session scheduled for late April. Given the short timeframe and limited scope of this task, it was agreed that the required report would be prepared jointly, but without calling a meeting of the JTC. This written report is a result of that collaborative effort.

2.0 2000 YUKON RIVER SALMON RUN OUTLOOKS

2.1 ALASKA

2.1.1 Chinook Salmon

Typically the majority of chinook salmon returning to the Yukon River are 6-year-old fish, though 5- and 7-year-old fish usually make up a significant contribution to the run. Spawning ground escapements in 1994, the brood year producing 6-year-old fish returning in 2000, were judged to be above average in magnitude. However, the return of 4- and 5-year-old fish returning in 1998 and 1999 appeared to be well below average in strength indicating abnormally poor production from the 1994 escapement. Additionally, the apparently low marine survival from age 5 fish returning in 1998, and sibling age 6 fish returning in 1999, continued recent below-average trends in survival. The 7-year-old return is expected to be below average based on the contribution of 5- and 6-year-old siblings from the 1993 parent year. The return of 5-year-old fish in 2000 is expected to be near average based on good spawning ground escapements in 1995 and the number of 4-year-old fish returning in 1999. Overall, the year 2000 chinook salmon run is anticipated to be weak to below average in strength for the third year in a row. The commercial harvest in Alaska is expected to be 25,000 to 65,000 chinook salmon (23,000 to 60,000 fish in the Lower Yukon Area and 2,000 to 5,000 fish in the Upper Yukon Area), representing a range of catch well below all other years except three others recorded during the previous 30 year period.

2.1.2 Summer Chum Salmon

Based on above average escapements in 1995 and 1996, an above average return of 4- and 5-year-old summer chum salmon would normally be expected. However, it appears that, similar to many chinook and chum salmon stocks in the Bering Sea region, recent declines in the productivity of summer chum salmon are continuing. Specifically, production of Anvik River chum salmon, which represents the largest spawning stock of Yukon River summer chum salmon, has fallen to well below 1 return per spawner for the 1993, 1994, and apparently 1995, brood years. Causes for the observed drop in productivity are still largely unknown. There is uncertainty as to how long this situation

might continue, and whether productivity could drop even further. There is a possibility that both low food productivity and high salmon density in the ocean environment may be contributing factors. It is possible that the extreme winter of 1995-96, characterized by very little snow cover, may also have adversely affected the survival of some stocks returning as age-4 fish in 1999, but nearly all stocks continue to exhibit decreased production levels, in some cases bordering on production failure. In addition, a relatively small number of age-3 fish from the 1996 brood year were detected in spawning tributary samples collected in 1999, indicating that low production levels may be continuing. Overall, the year 2000 outlook is for a weak to below average summer chum salmon run. The commercial harvest is expected to be 25,000 to 300,000 fish given uncertainties associated with recent declines in productivity and market conditions.

2.1.3 Fall Chum Salmon

Drainage-wide, Yukon River fall chum salmon escapements for the period 1974 through 1993 have been estimated by ADF&G to have ranged from approximately 110,000 (1982) to 1,200,000 (1975), based upon expansion of escapement assessments for selected stocks to approximate overall escapement abundance. Escapements in these years resulted in subsequent returns that ranged in size from approximately 301,000 (1988 production) to 1,400,000 (1975 production) fish, using the same approach to approximating overall escapement. Corresponding return per spawner rates ranged from 1.1 to 4.5, averaging 2.5 for all years combined.

Yukon River fall chum salmon return primarily as age-4 or age-5 fish, although age-3 and age-6 fish also contribute to the run. A Ricker spawner-recruit model was used to predict the returns from the 1994 to 1997 parent years that will contribute to the 2000 run. This process resulted in a projection of 1,137,000 fall chum salmon with the following approximate age composition:

Age-3 fish	15,000 (1997 Brood Year)	1.3 %
Age-4 fish	719,000 (1996 Brood Year)	63.3 %
Age-5 fish	382,000 (1995 Brood Year)	33.6 %
Age-6 fish	21,000 (1994 Brood Year)	1.8 %

However, there is a level of uncertainty associated with the 2000 Yukon River fall chum salmon outlook. Very dramatic declines in salmon returns to Western Alaska occurred in 1997 and 1998. This trend continued for most areas in 1999. While exact reasons for the run failures are unknown, it is widely speculated that poor marine survival related to localized weather and ocean conditions in the Bering Sea are primary factors. Weakness in the salmon runs has been attributed to reduced productivity and not the result of low levels of parent year escapements.

The major contributor to the 2000 fall chum salmon run is anticipated to be age-4 fish returning from the 1996 parent year. A very strong fall chum salmon run occurred that year, with excellent escapements observed throughout most of the drainage. All escapement

goals were met in 1996 with the exception of the Toklat River. However, should the factor(s) that affected the productivity of fish from the parent years that returned in 1998 and 1999 carry over to fish expected to return in 2000, then a weak return is once again likely to materialize. If so, the return of Yukon River fall chum salmon in 2000 may be 50% or less of the otherwise normal point projection of 1,137,000 fall chum salmon. This results in a range in the projected return for 2000 of approximately 569,000 to 1,137,000 fall chum salmon.

The potential for another weak return is not unreasonable given recent trends. It is also noteworthy that the projection of 1,137,000 chum salmon includes an estimated 719,000 age-4 fish returning from the 1996 brood year. The return of age-4 fish from even-numbered brood years during the most recent decade has averaged only 398,000 chum salmon, ranging from 147,000 for brood year 1988 to a high of 617,000 for brood year 1992. Furthermore, total run size has never reached one million chum salmon for any even-numbered year on record. The largest was estimated in 1996 at 988,000 fall chum salmon (average is 613,000). It is likely that total run size in 2000 is more likely to materialize toward the lower end of the projected range.

2.1.4 Coho Salmon

Although comprehensive escapement information on Yukon River drainage coho salmon is lacking, it is known that coho salmon have later and overlapping run timing with fall chum salmon, and primarily return as age-4 fish. Assuming average survival, an average to above average return of coho salmon would be anticipated in 2000, based upon parental escapement levels observed in several spawning streams in 1996. However, should mortality factors that contributed to Western Alaska salmon run failures in recent years also affect marine survival of coho salmon from the 1996 brood year, then a below average run of coho salmon could materialize in 2000.

The Alaska Board of Fisheries recently adopted a Yukon River coho salmon management plan that would allow a directed commercial coho salmon fishery, but only under very unique conditions. Such a directed commercial coho salmon fishery is not likely to occur in 2000, and it is anticipated that any commercial harvest of coho salmon will be dependent upon the abundance of, and incidental to, the harvest of fall chum salmon.

2.2 CANADA

2.2.1 Upper Yukon Chinook Salmon

The expected total run size of Canadian origin, upper Yukon¹ River chinook salmon for 2000 is in the range of 91,000 to 128,000 fish. By comparison, the upper Yukon chinook

¹ The upper Yukon River, for the purpose of Section 2.2 of this report, is defined as the Canadian portion of the Yukon River drainage excluding the Porcupine River drainage.

run size averaged approximately 123,000 fish during the recent six-year cycle from 1994 to 1999². The 2000 run is therefore expected to be **weak to average** in magnitude.

The 2000 run outlook is based on escapement data for 1992 through 1997, and calculated returns per spawner for the individual brood year escapements based on the spawner-recruitment relationship for the 1980 to 1992 brood years. It is expressed as a range due to the uncertainty associated with marine survival. The potential for reduced marine survival has been made apparent by the 1998 and 1999 returns of upper Yukon chinook salmon, which were significantly below expectations.

The interim escapement goal range for rebuilt upper Yukon chinook (excluding the Porcupine) is 33,000 to 43,000 chinook salmon. Recognizing that chinook escapements were depressed, the Yukon River Panel developed a rebuilding goal of >28,000 for the period 1996 through 2001 which both Parties have been endeavouring to manage towards. Two of the three principal brood years for the 2000 run exceeded this target, whereas all were below the lower end of the target range for rebuilt stocks.

The run outlook for 2000 was developed using the relationship between spawning escapement and production for the 1980 to 1992 brood years and factoring in the potential for reduced marine survival. Production estimates incorporated age composition data from escapements, and from harvests of Canadian origin chinook salmon in the U.S. and Canada. Annual returns were reconstructed using ADF&G scale pattern data and Fisheries and Oceans Canada tagging results. When age composition data were not available for individual years, averages were substituted, or, in the case of spawning escapements, adjusted age data from the Fisheries and Oceans Canada fishwheels upstream of the Canada/U.S. border were used. Total escapements for 1980-81 and 1984 were estimated by expanding a cumulative five-area escapement index (Tatchun Cr., Big Salmon R., Nisutlin R., Wolf R., and the non-hatchery returns to the Whitehorse Fishway) by the average proportion the index represented of the total escapement estimates. Mark-recapture results were used to estimate the escapement in 1982, 1983 and 1985 through 1999.

The relationship between the natural logarithm of the return per spawner (R/S) and number of spawners (S) for the 1980 to 1992 brood years is described as follows:

$$\text{Equation [1]: } \ln(R/S) = 2.43 - 0.000032(S);$$

where: S = # spawners (in thousands), R = returns.

The coefficient of determination (r^2) of this regression is 0.45 and the relationship is significant ($p < 0.05$).

The 2000 return was estimated by first, calculating the total expected return from each brood year escapement based on equation [1] and then, apportioning it by the average age composition of brood year returns. For example, the escapement of 25,890 chinook in 1994 is expected to produce 127,355 chinook, all ages combined. However, only age-6

² The 1999 run size estimate is preliminary.

chinook will be returning in 2000 from the 1994 brood year. To calculate the number of age-6 chinook expected from the 1994 brood year, the expected total production of 127,355 was apportioned by the average age composition of brood year returns. Over the 1980-1992 period, the average age composition of brood year returns is as follows: <0.01% age-3, 4.6% age-4, 24.4% age-5, 57.2% age-6, 13.3% age-7, and 0.4% age-8. Therefore, it is expected that 57.2% (rounded) of the production from 1994 will return as age-6 chinook in 2000; this equals 72,878 fish. The calculations for this and the other brood years are summarised in the table below:

Brood Year	Escapement	Calc'd Ln(R/S)	Calc'd R/S	Est'd prod'n	2000 Return
1992	25,382	1.610	5.001	126,931	520
1993	28,558	1.507	4.511	128,831	17,146
1994	25,890	1.593	4.919	127,355	72,878
1995	32,262	1.386	4.000	129,061	31,443
1996	28,409	1.511	4.533	128,780	5,984
1997	37,683	1.211	3.355	126,434	60
total					128,031
Upper end of 2000 expected run size range (rounded)					128,000
Lower end of 2000 expected run size range					91,000

The point estimate of 128,000 chinook salmon does not incorporate the recent trend towards decreased marine survival and therefore is considered to be optimistic. A similar approach in 1999 based on traditional production models resulted in a run outlook of 136,000 for 1999. However, the preliminary estimate of the 1999 upper Yukon chinook run size was approximately 96,300 fish, 71% of the expected run size. If the 2000 approach over-estimates the actual run size in 2000 by the same margin, it would be more realistic to expect a run size closer to 91,000 chinook salmon in 2000. This is reflected in the table above and is used to give a lower bound to the 2000 outlook.

Chinook run outlooks based on stock-recruitment data have been included in the Canadian Yukon management plans since 1991. To examine how well this method has performed, annual run outlooks based on stock-recruitment data as described in respective plans since 1991, were compared to actual estimated run sizes. Over the period 1991 to 1999, the mean absolute percent error was 25%. In other words, for this period of time, the annual forecasts were off by an average of 25% (range = 3% to 112%). Run forecasts over-estimated the actual run sizes in four years, and underestimated them in five years. Not surprisingly, the years with the greatest discrepancies included 1998, in which the forecast overestimated by 112%, and 1999 when the forecast overestimated by 41%. As inferred previously, a significant reduction in marine survival could explain the poor performance of the forecasts in these years. If these two years are ignored, the mean absolute percent error is reduced to about 10%.

2.2.2 Upper Yukon Chum Salmon

An average of 62% of upper Yukon adult chum salmon return at four years of age and 35% return at five years of age. This suggests that the major portion of the 2000 fall chum run should originate from escapements of 158,092 in 1995 and 122,429 in 1996.

The brood year escapements represent the highest escapements recorded and are well above the recent (i.e. 1996-1999) cycle average of approximately 80,000 fish and the minimum escapement goal for rebuilt upper Yukon chum salmon of >80,000 fish.

A return rate of 2.5 adults per spawner (R/S) was used in the joint Canada/U.S. upper Yukon chum salmon rebuilding model and has been used in most years by Fisheries and Oceans Canada for developing pre-season run expectations³. It matches the long-term (i.e. 1974-1992) R/S for the estimated drainage-wide Yukon River fall chum stock aggregate. The 2000 expectation using this rate is a run size of 334,000 fall chum salmon, which is very close to the upper end of the expected range in 1999 of 336,000. However, the 1999 estimated upper Yukon River fall chum run size of 106,600 was only 32% of the upper range of the anticipated run size, likely as a result of poor marine conditions. It is reasonable to assume that these conditions may prevail and a similar run shortfall could occur in 2000. The 2000 run size expectation is therefore expressed as a range from 107,000 to 334,000 chum salmon.

Brood Year	Escapement	Est'd prod'n @ 2.5 (R/S)	% contribution based on age	2000 Return
1994	98,358	245,895	0.017	4,138
1995	158,092	395,230	0.346	136,826
1996	122,429	306,073	0.616	188,578
1997	85,439	213,598	0.021	4,455
Total run				333,977
Upper end of 2000 expected run size range (rounded)				334,000
Lower end of 2000 expected run size range (rounded)				107,000

Although insufficient stock identification data are available for accurately estimating annual run sizes of upper Yukon chum salmon, assumptions have been made to allow the 2000 outlook to be expressed in terms of recent run sizes. Run size estimates for previous years were developed based on the following Fisheries and Oceans Canada assumptions:

³ The adult per spawner return (R/S) for the 1982 to 1994 brood years was 2.3 while the return for the most recent cycle year period (1991-94) was 2.5. The R/S for brood year 1994 was only 0.7, and this was attributed to low marine survival.

- (a) 30% of the total U.S. catch of fall chum salmon is composed of Canadian origin fish;
- (b) the U.S. catches of Canadian-origin upper Yukon and Porcupine fall chum are proportional to the ratio of their respective border escapements; and,
- (c) the Porcupine border escapement consists of the Old Crow aboriginal fishery catch plus the Fishing Branch River escapement.

Using these assumptions, the recent four-year cycle (1996-1999) return of upper Yukon Canadian-origin chum salmon is estimated to have been approximately 122,000 fish. In comparison, the 2000 upper Yukon chum salmon expectation of 107,000 to 334,000 fish ranges from **below average to above average**.

The chum salmon run to Canadian portions of the Porcupine drainage in 2000 should originate primarily from the 1995 and 1996 escapement. The escapement to the Fishing Branch River, as determined by a weir count, was 51,971 chum salmon in 1995 and 77,278 in 1996. These counts were well above the 1996-1999 cycle average of 32,395 fish and they exceeded the lower end of the interim escapement goal range of 50,000 to 120,000 chum salmon.

The productivity of the upper Porcupine River chum stocks appears to be lower than that of both the drainage-wide stock aggregate and the upper Yukon stock aggregate, particularly when averaged over the 1988 to 1991 brood years. (The returns from the 1992 and 1993 brood years have not yet been estimated). Rather than using a R/S value of 2.5, Fisheries and Oceans Canada has prepared a stock-recruitment brood table using the assumptions listed above. The average productivity of brood years 1982 through 1991 was estimated to be a R/S rate of 2.2, and this was used to develop the 2000 forecast.

Assuming a R/S value of 2.2, and using the average age at maturity for upper Porcupine chum salmon of 60% age-four and 36% age-five, a return of 150,000 fish is expected in 2000.

Brood Year	Escapement	Est'd prod'n @ 2.2 (R/S)	%contribution based on age	2000 Return
1995	51,971	114,336	0.36	41,610
1996	77,278	170,011	0.60	102,007
Sub-total				143,617
Total (adjusted for other age classes)				149,601
Upper end of 2000 expected run size range (rounded)				150,000
Lower end of 2000 expected run size range				28,000

The total Canadian-origin Porcupine chum run size was estimated to have been approximately 50,000 fish over the 1996-1999 four-year cycle (based on the assumptions previously stated). As with the upper Yukon River chum expectation, it was felt that the

expected run size should be expressed as a range, in light of the run shortfall experienced in 1999. In 1999, the estimated run size of 23,300 chum salmon was only 19% of the expected run size of 124,000 fish. The outlook of 150,000 fish for 2000 was therefore reduced by 81% to obtain the lower end of the expectation range. Therefore, a return of between 28,000 and 150,000 chum salmon is expected for 2000. Relative to recent run sizes these values also range from **below average to above average**. As with the 1999 expectations, the upper Porcupine expectation has been expressed with some ambiguity due to the uncertainty associated with marine conditions.